

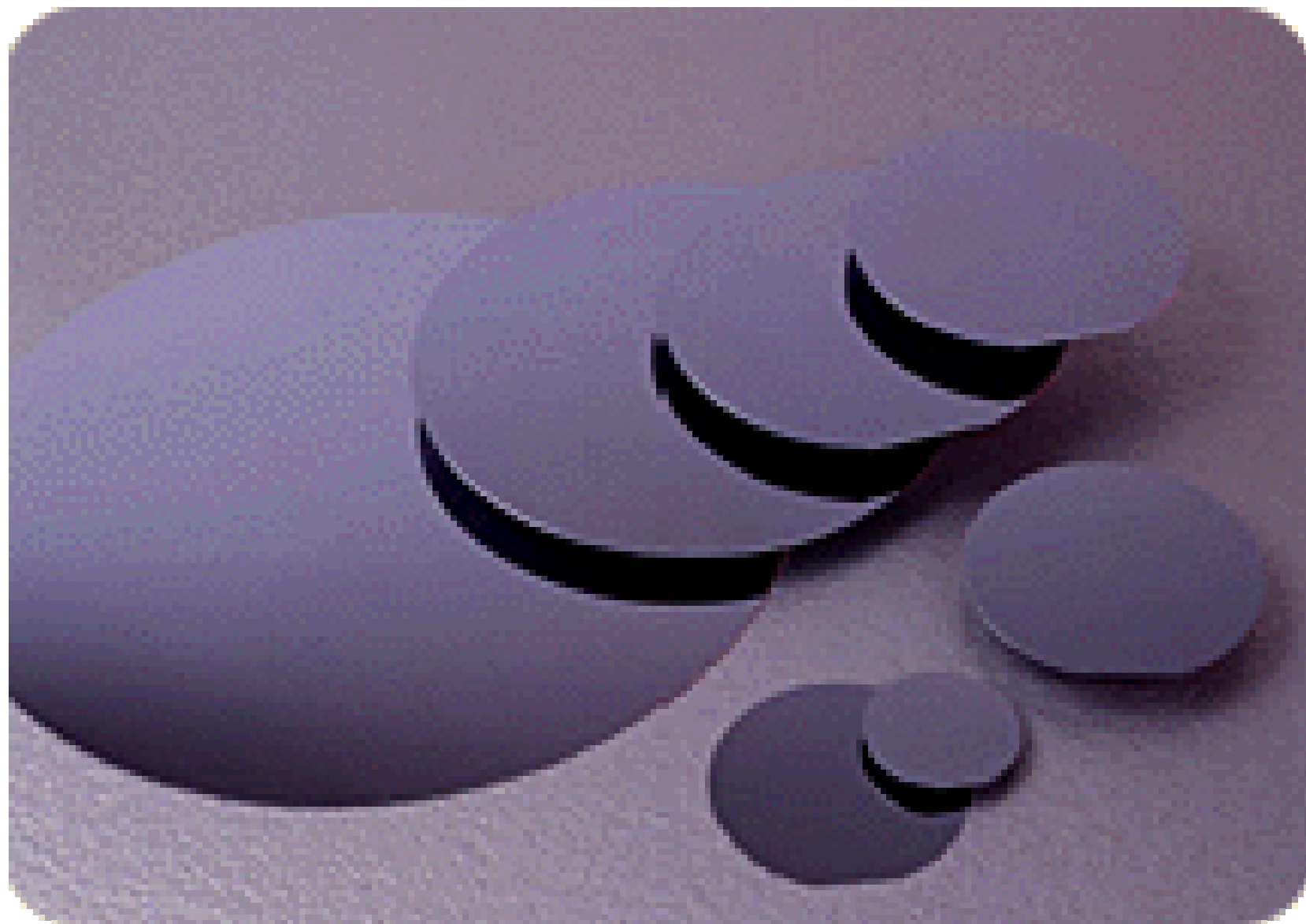
Conformal Sheets of Thin Film Sensors, Electronics and Energy Harvesters for Structural Monitoring

- Motivation, Perspective
- Materials, Assembly Techniques
- Structural and Human Status Monitoring

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Electrical and Computer Engineering, Bioengineering
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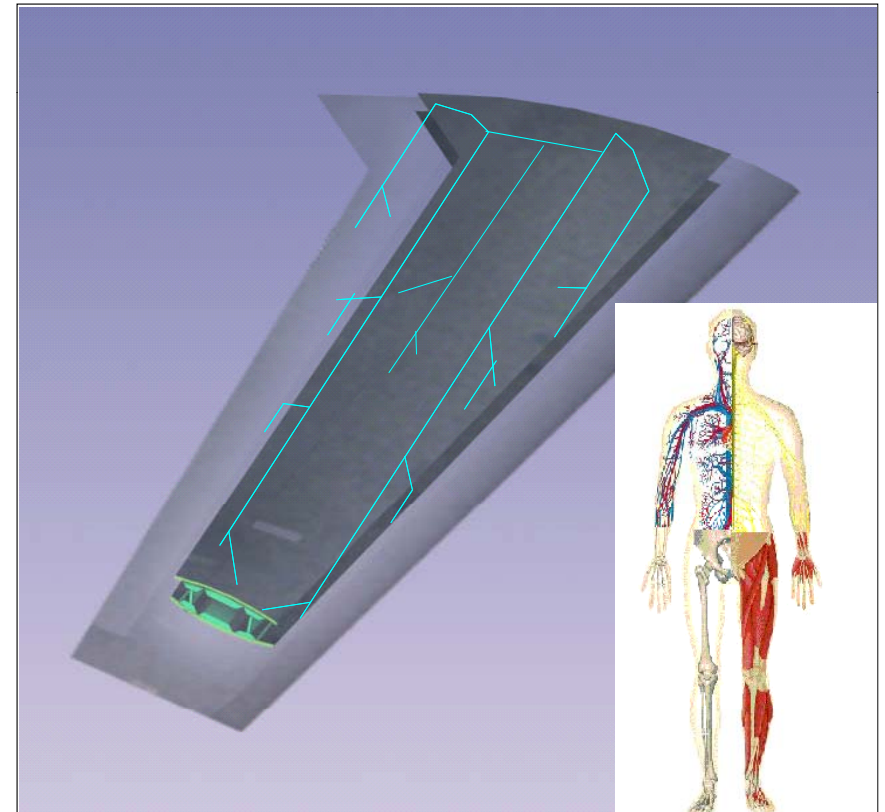
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Structural Health Monitors for Aerospace

The Living Airframe – B. Baron/AFRL



Macroelectronics for Advanced Medical Systems

Intelligent, Wireless Medical Sensors



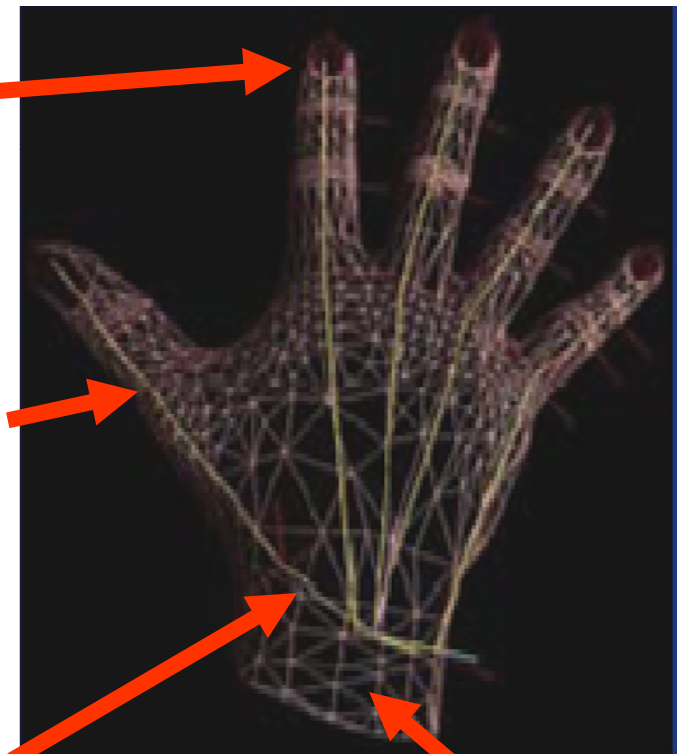
Smart Surgical Glove

μ sensors:
chemical,
optical,
thermal

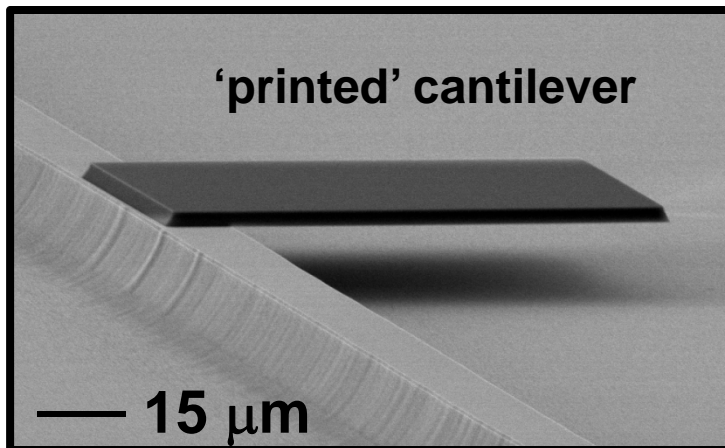
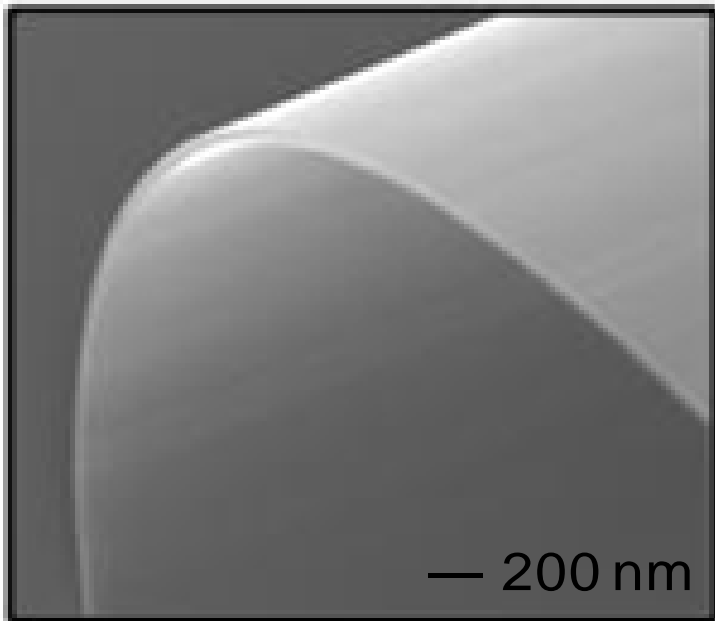
μ fluidic
channels

embedded
integrated circuits

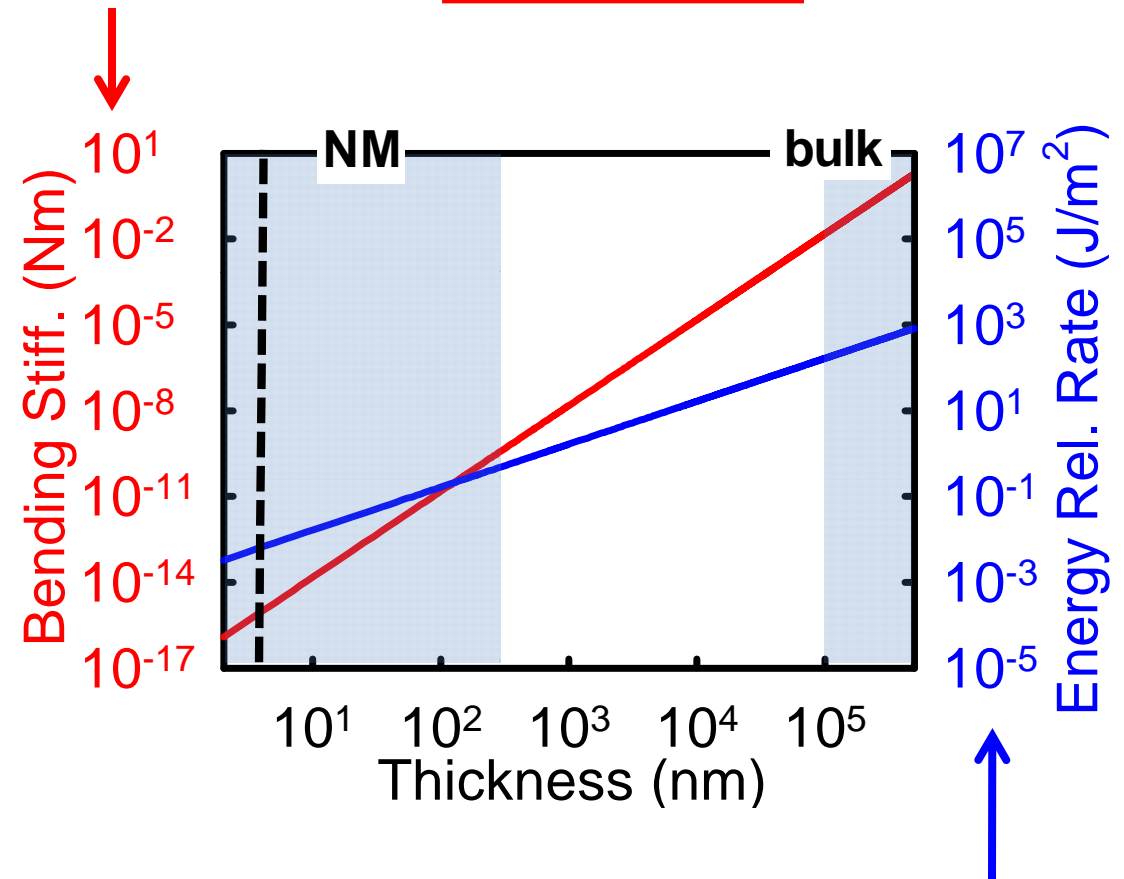
RF transmit/receive



Mechanics of Silicon NanoMembranes



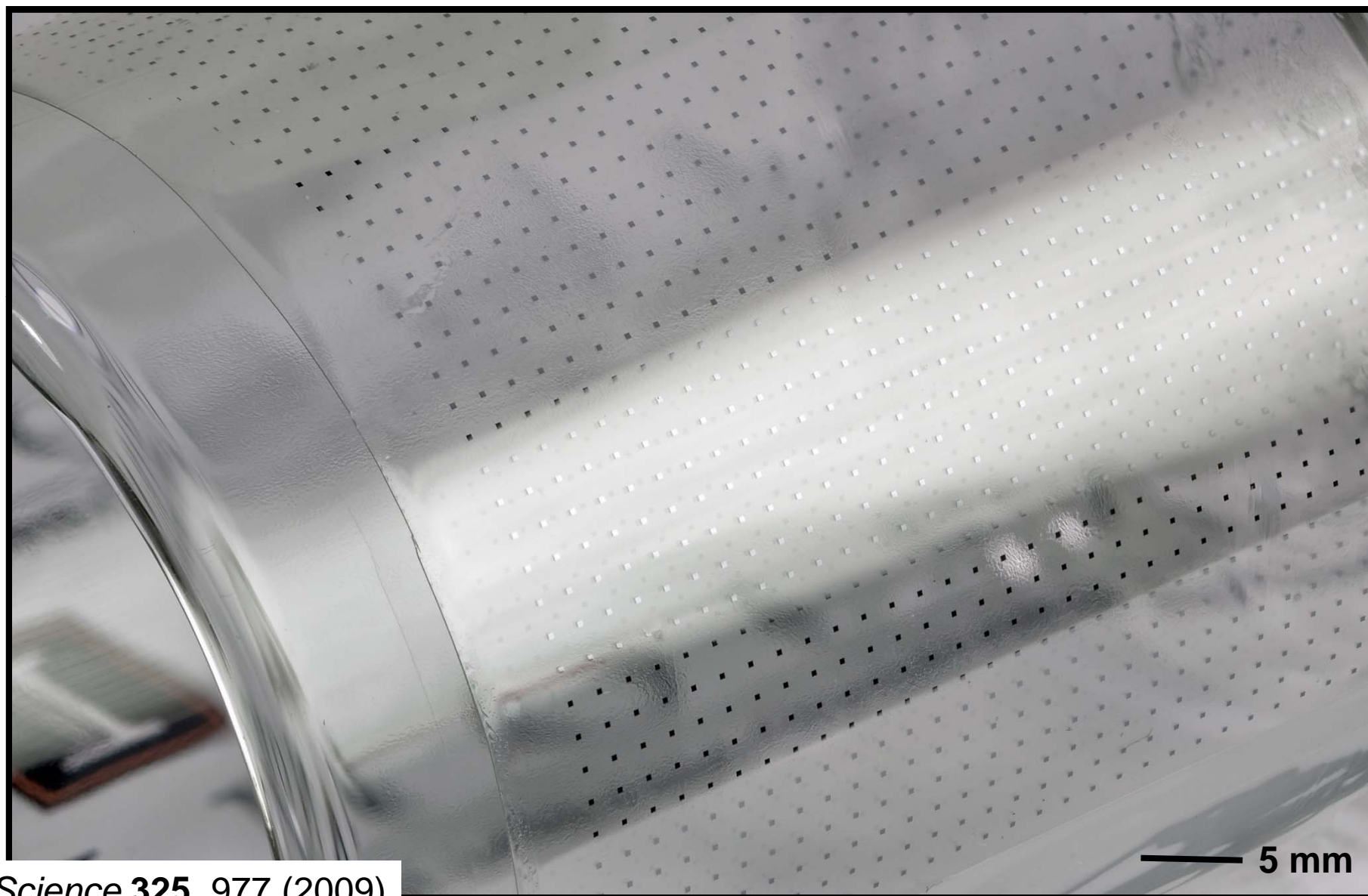
$$EI \sim Eh^3 \quad \text{and} \quad \varepsilon_{peak} \sim h / R$$



$$G \sim h(\alpha_1 - \alpha_2)^2 \Delta T^2$$

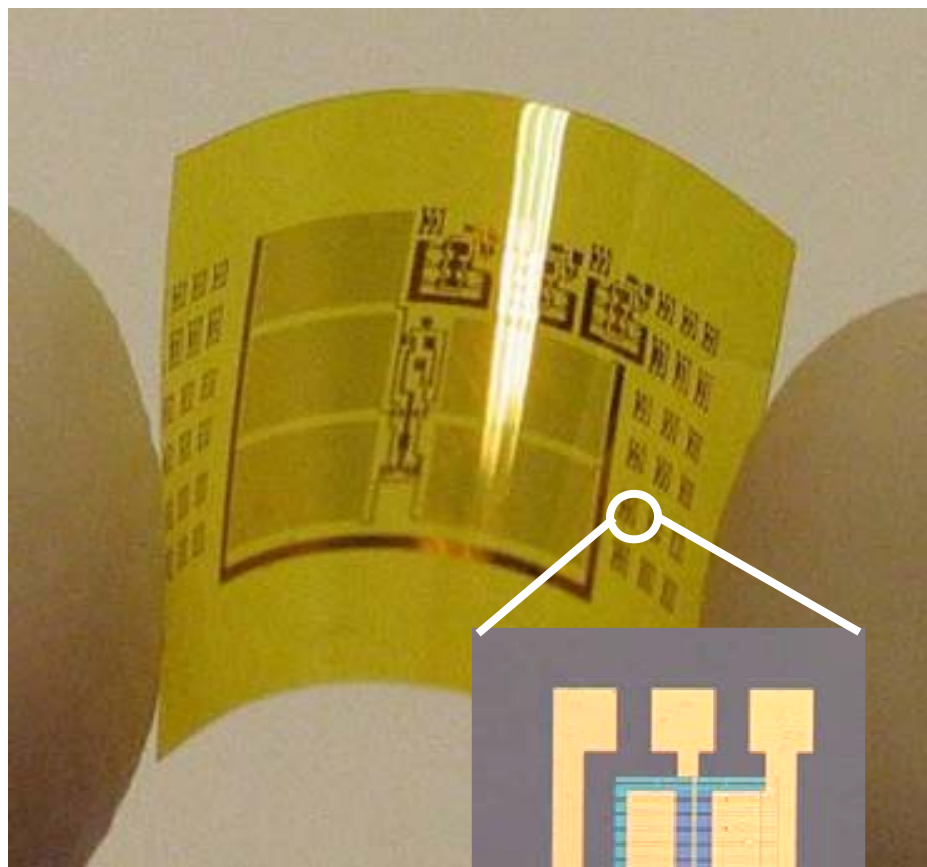
Nature, **477**, 45 (2011).

GaAs Membranes Printed Onto Plastic (1600; 100% yield)

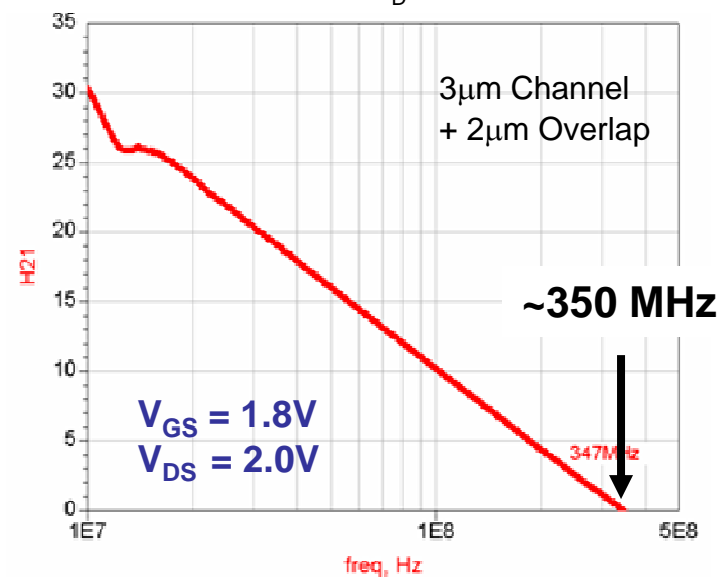
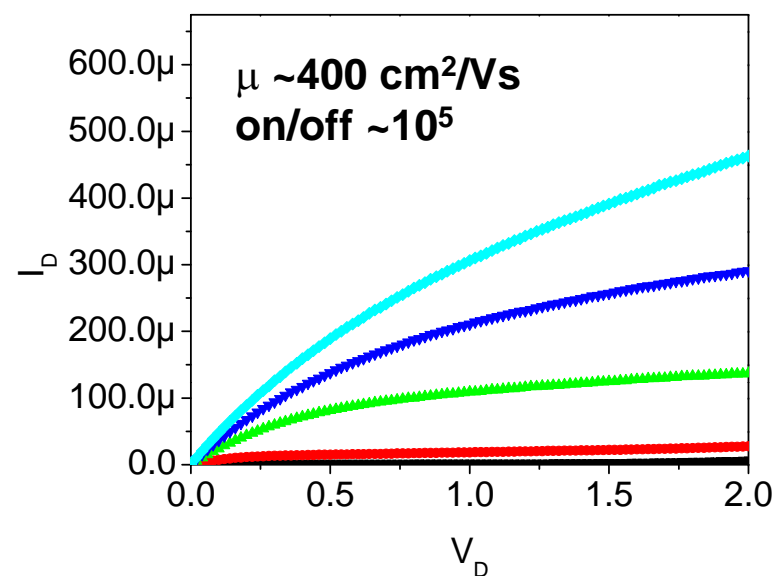


Science **325**, 977 (2009)

Single Crystal Silicon TFTs and Circuits on Plastic

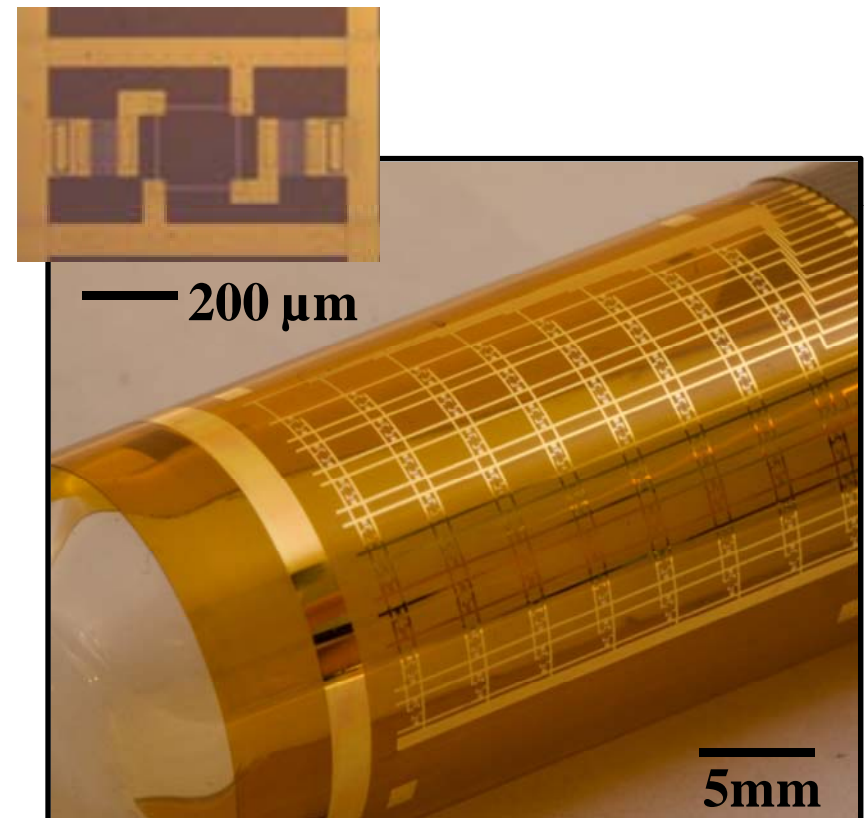
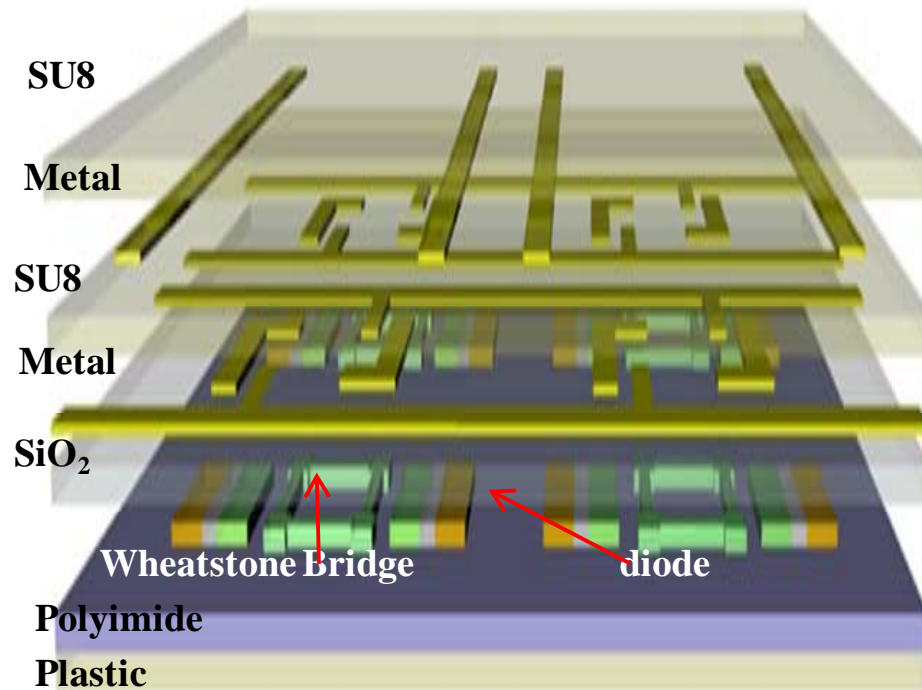


– 10 μm

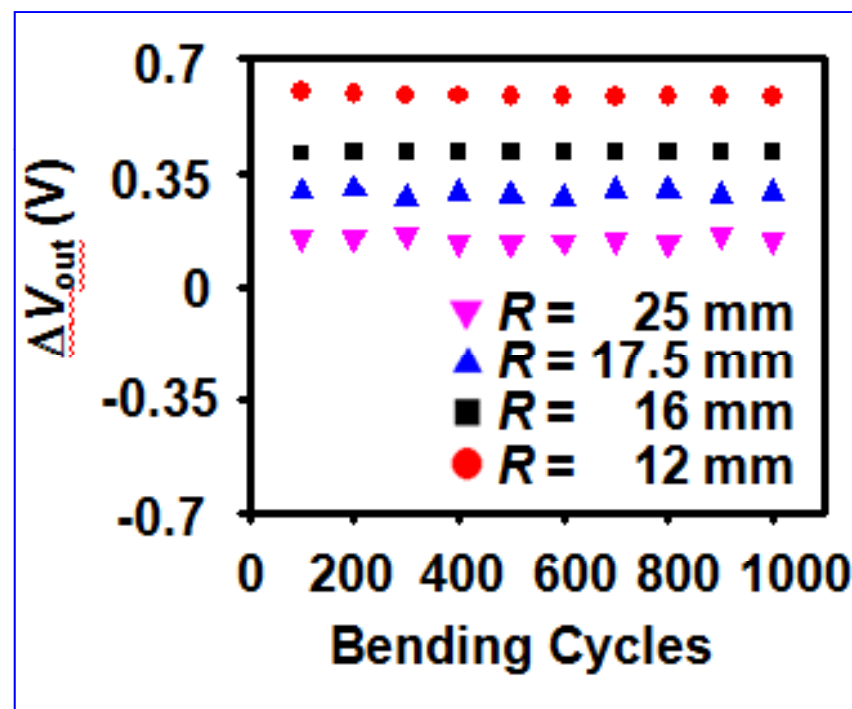
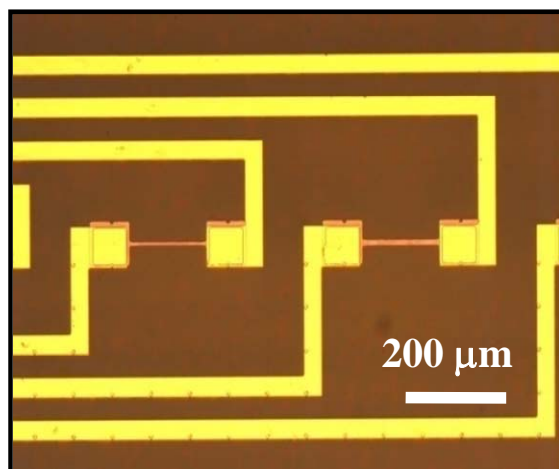
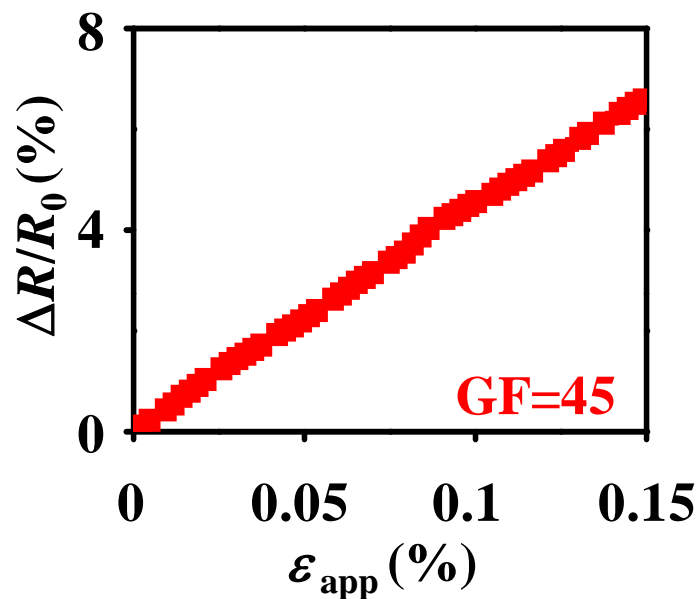


IEEE Electron Dev. Lett., **27**(6) 460 (2006).

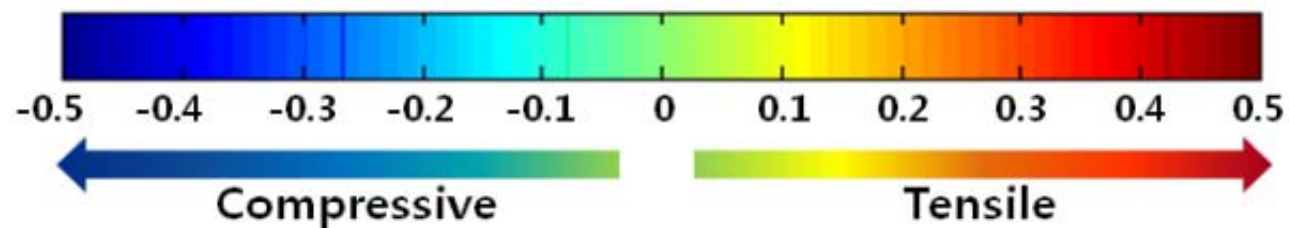
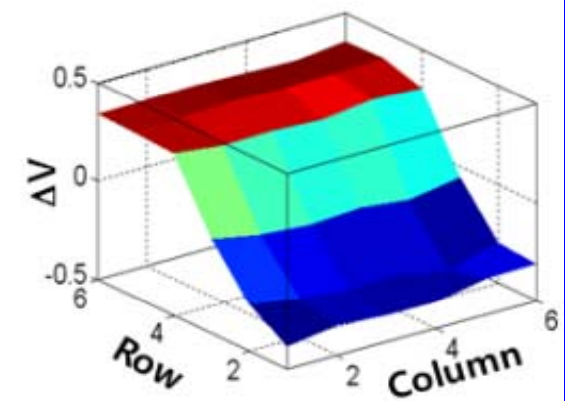
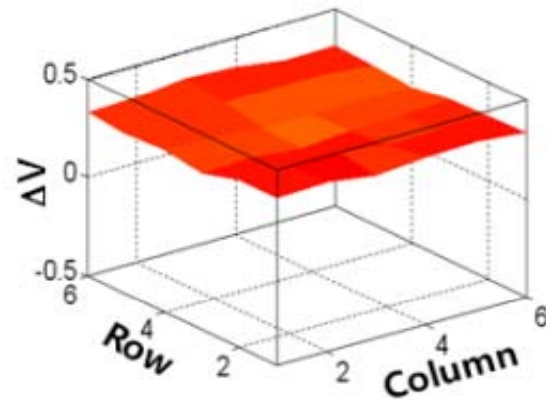
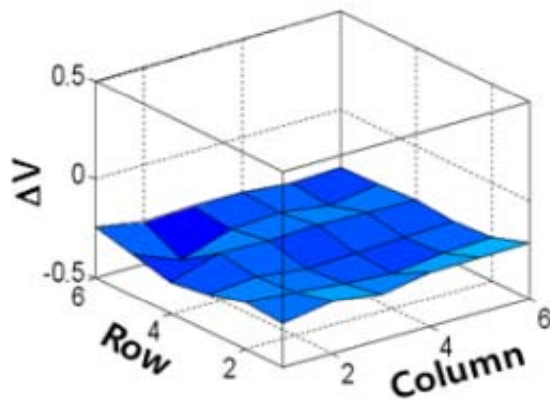
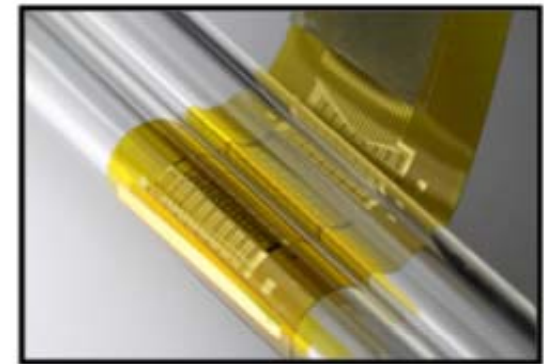
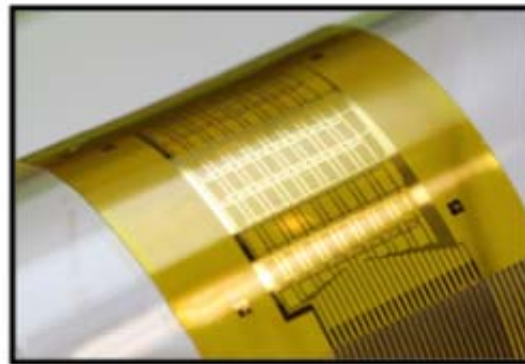
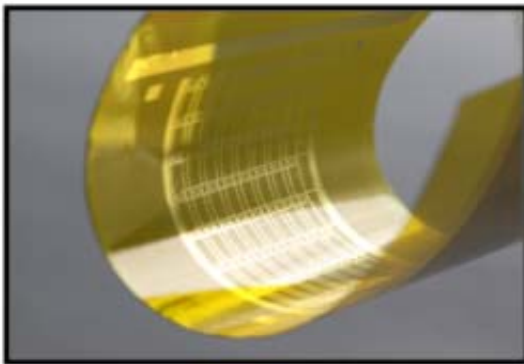
Flexible, Multiplexed Silicon Strain Gauges



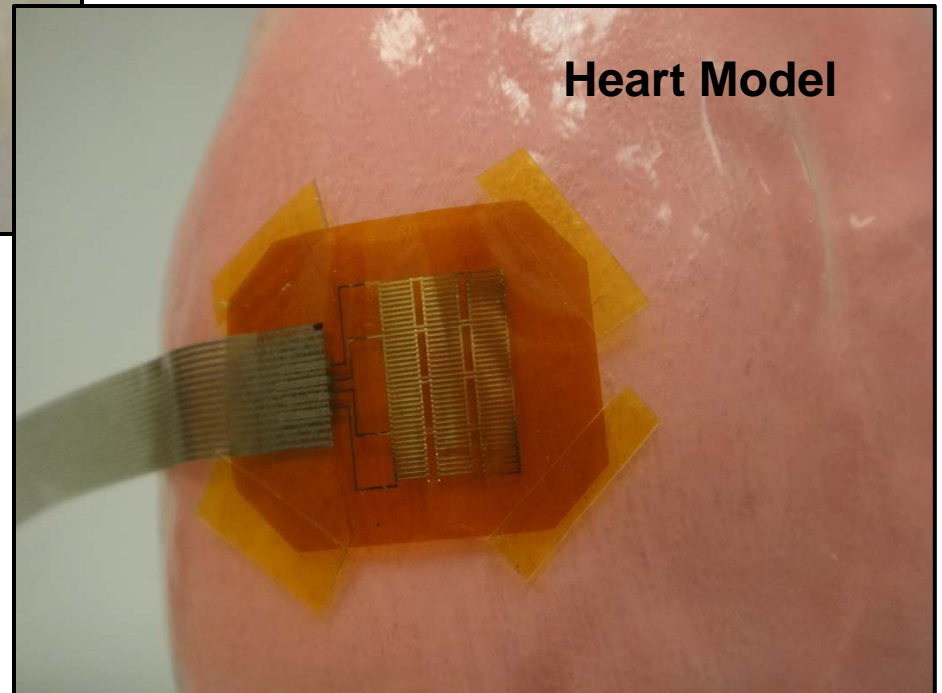
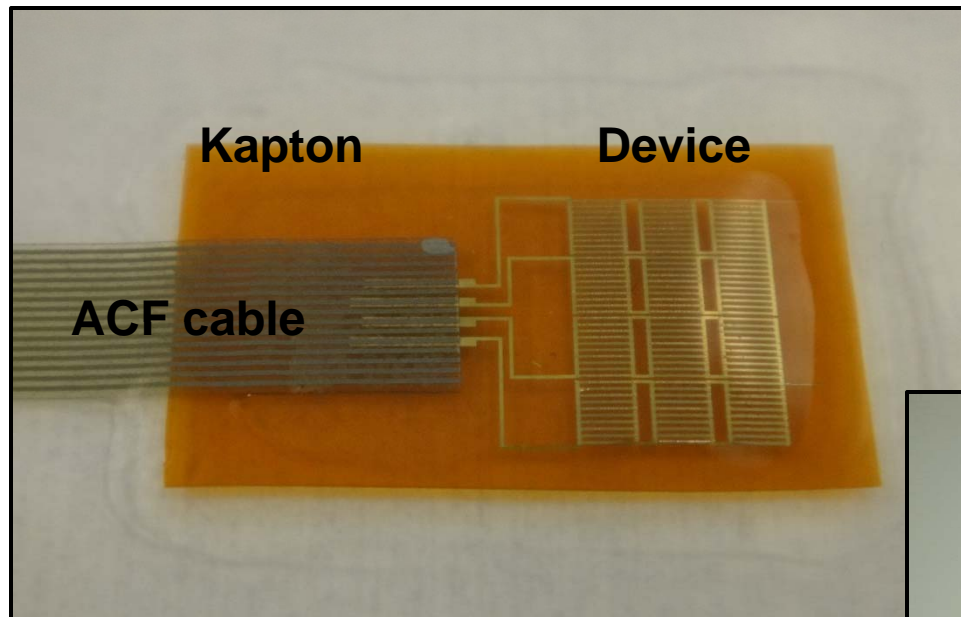
Flexible Silicon Strain Gauges – Performance



Strain Mapping with Flexible Silicon Strain Gauges

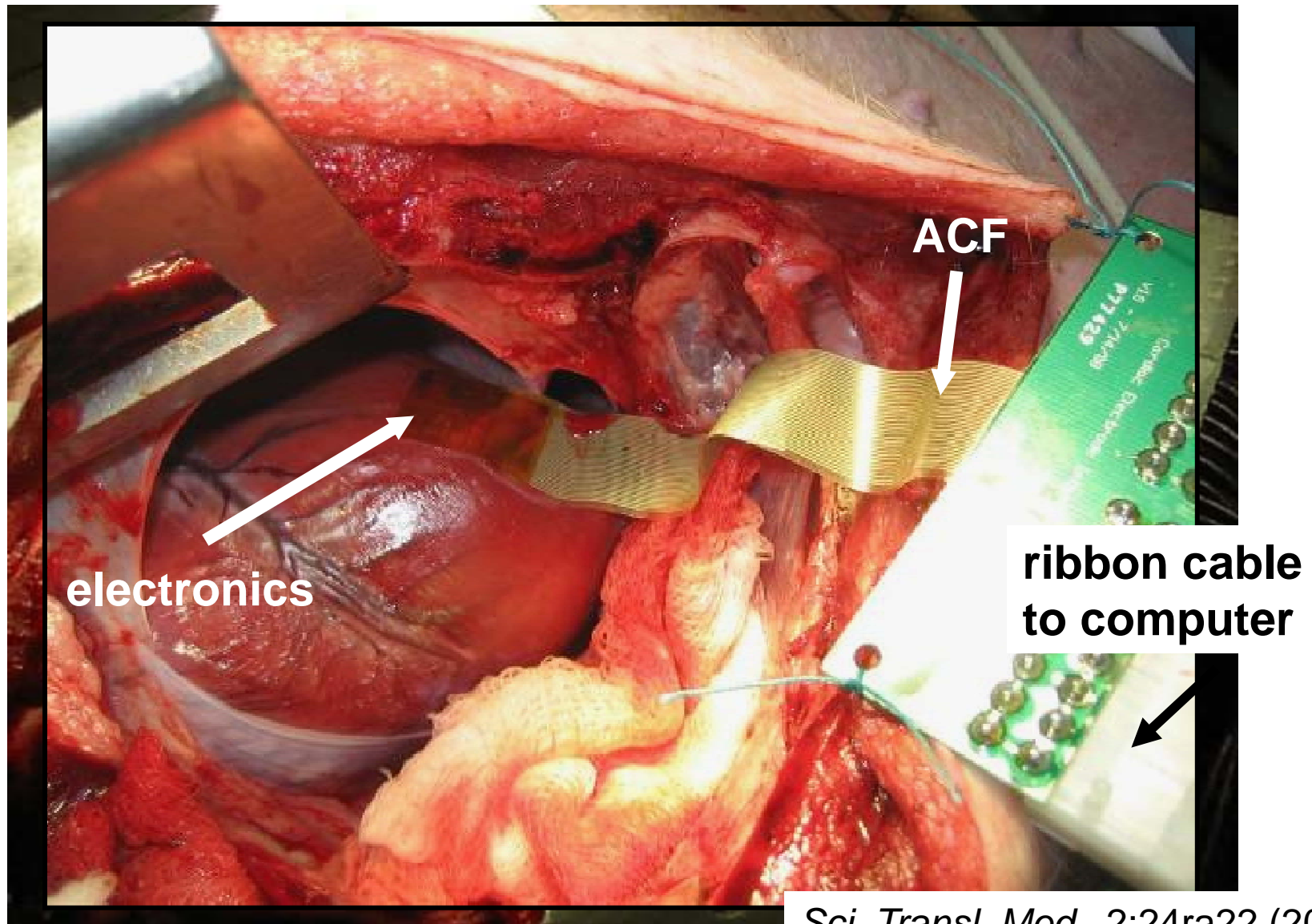


Energy Harvesting with Flexible PZT Elements



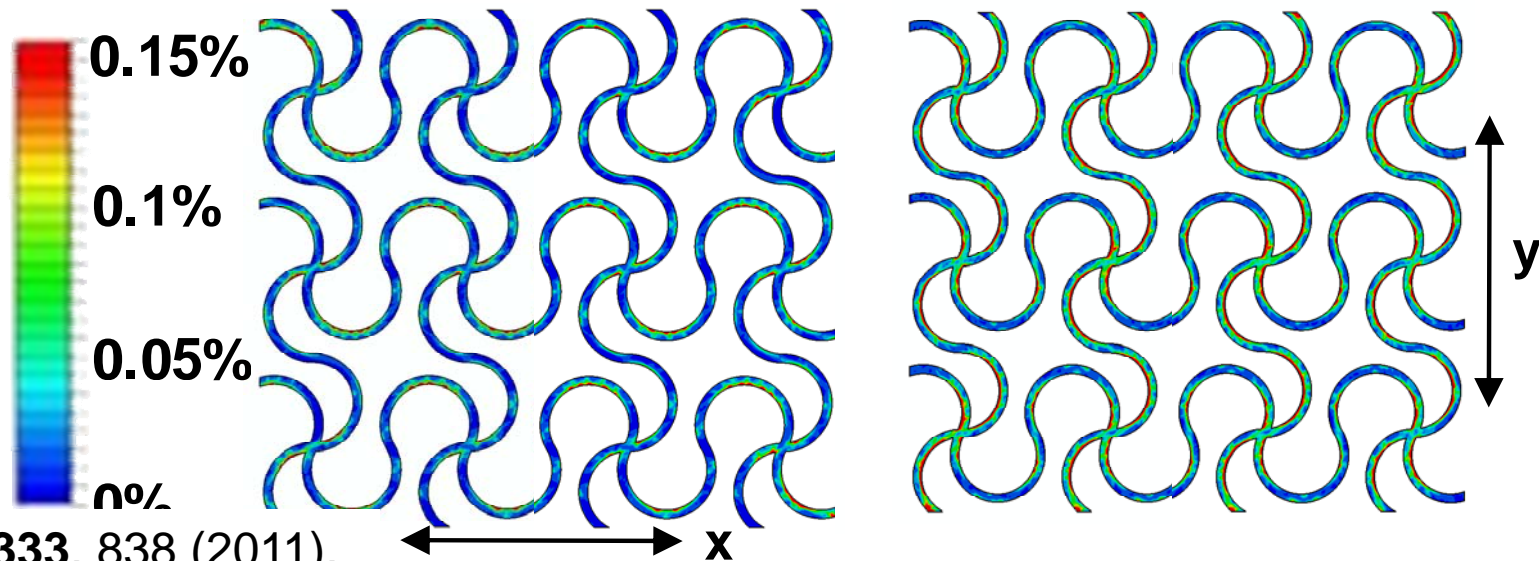
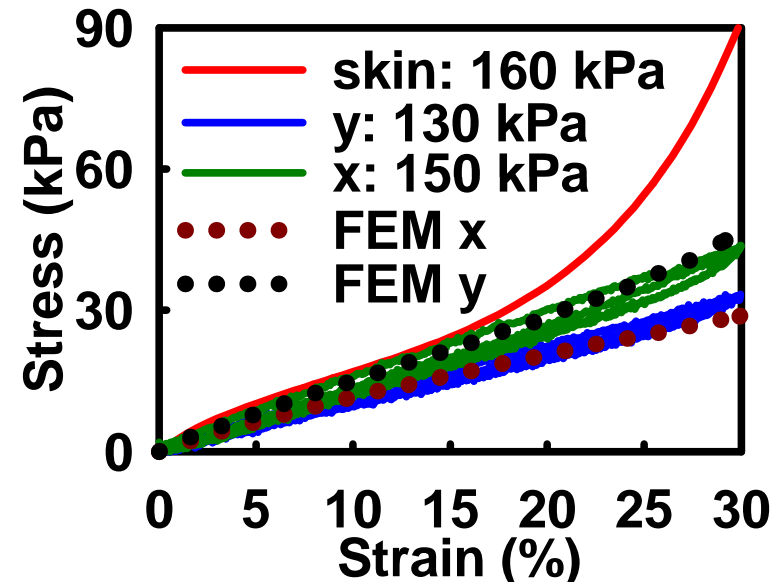
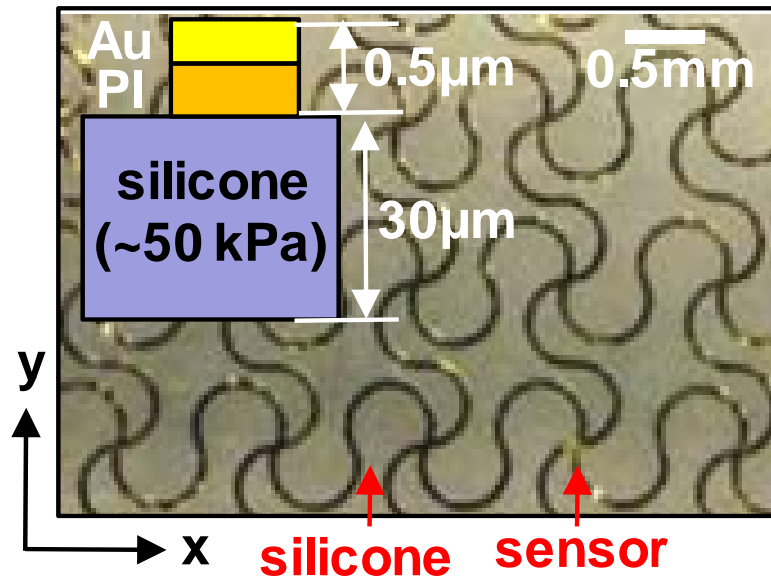
unpublished

Thin, Epicardial Sensing / Harvesting 'Tapes'



Sci. Transl. Med., 2:24ra22 (2010)

Mechanics in Filamentary Serpentine EES



Skin-Like Silicon Electronics

Skin Mounted, Deformed



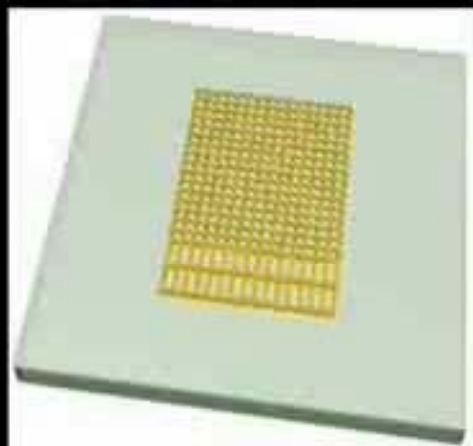
Science **333**, 838 (2011).

Free Standing



— 3 mm

Dissolving Backing Substrate with Water



transfer to
ecoflex/PVA

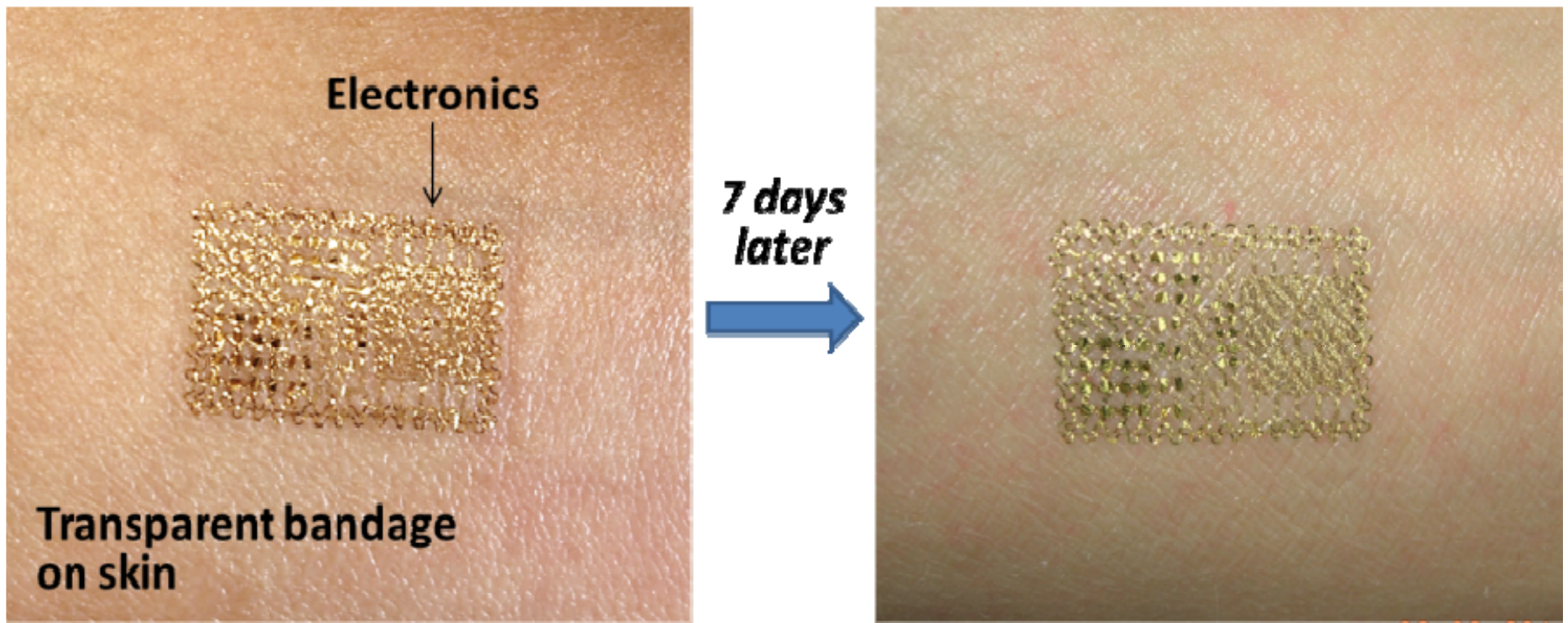


apply to skin



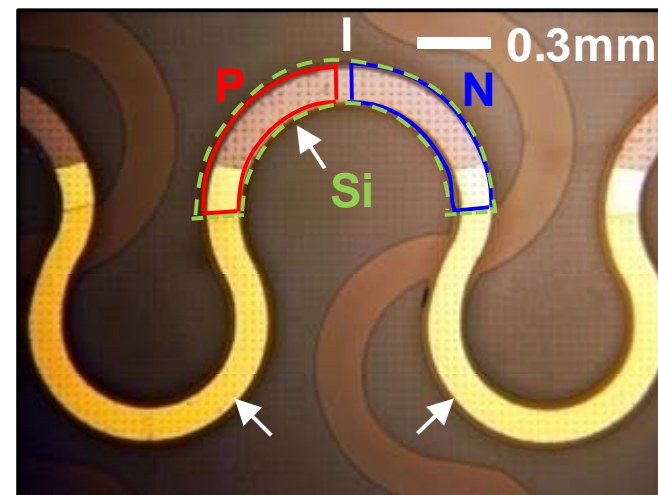
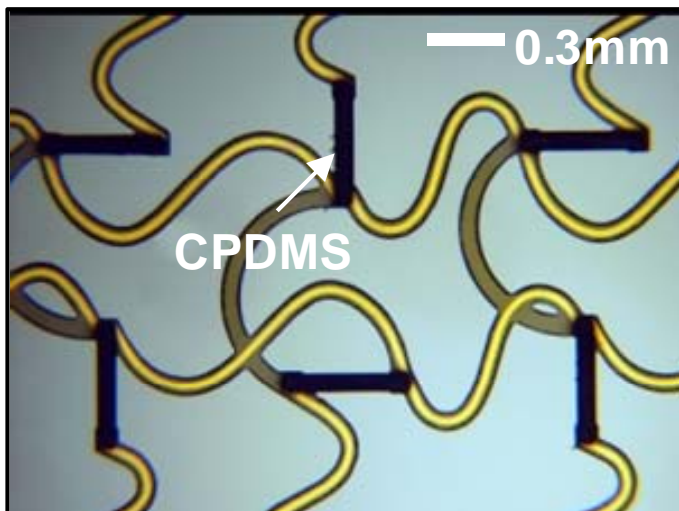
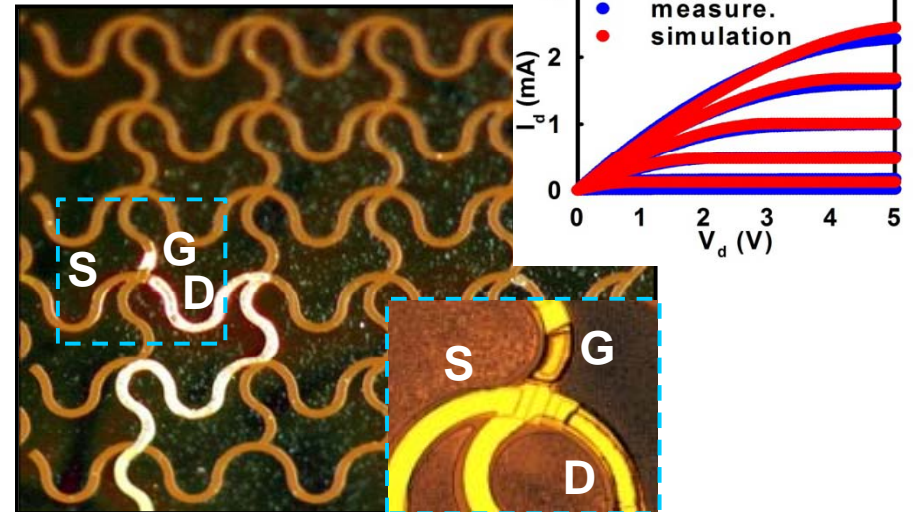
dissolve
backing PVA

Wearability of Current FS-EES Devices



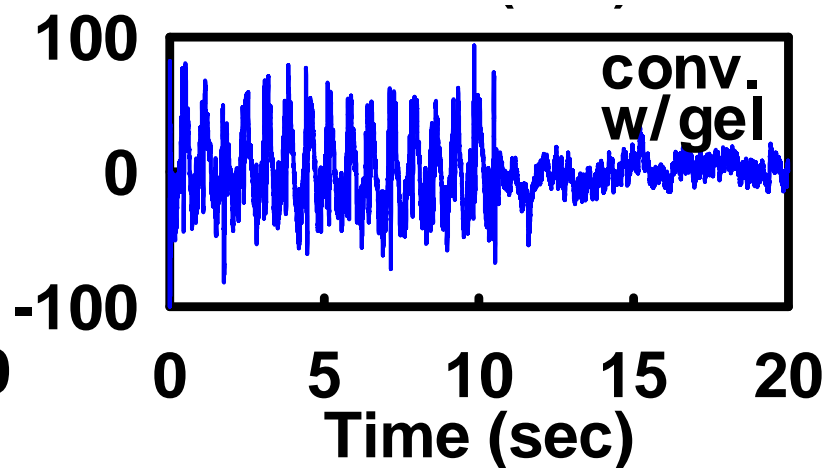
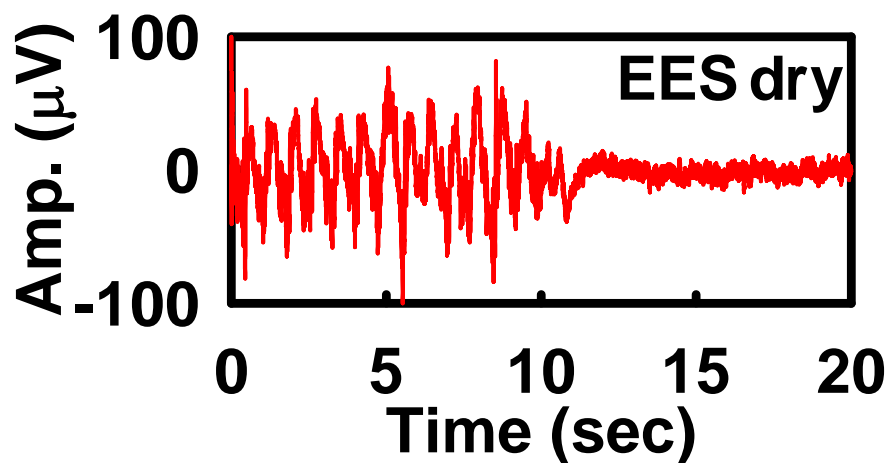
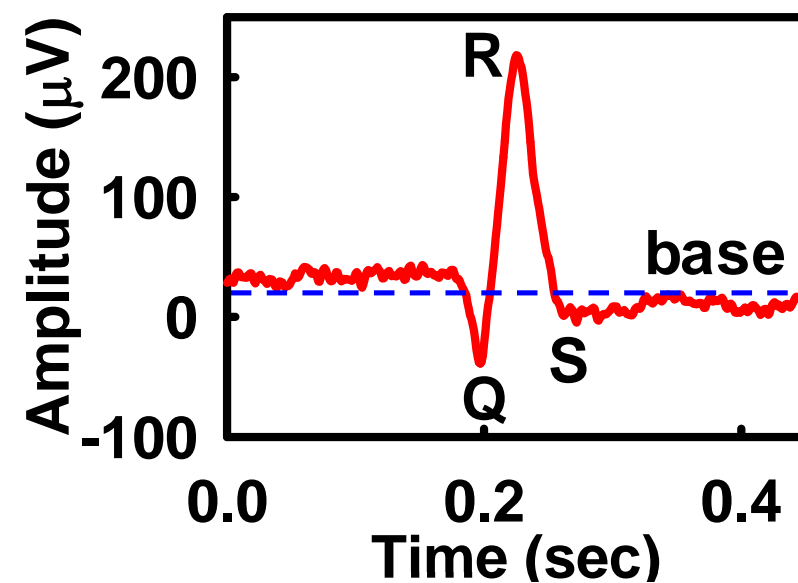
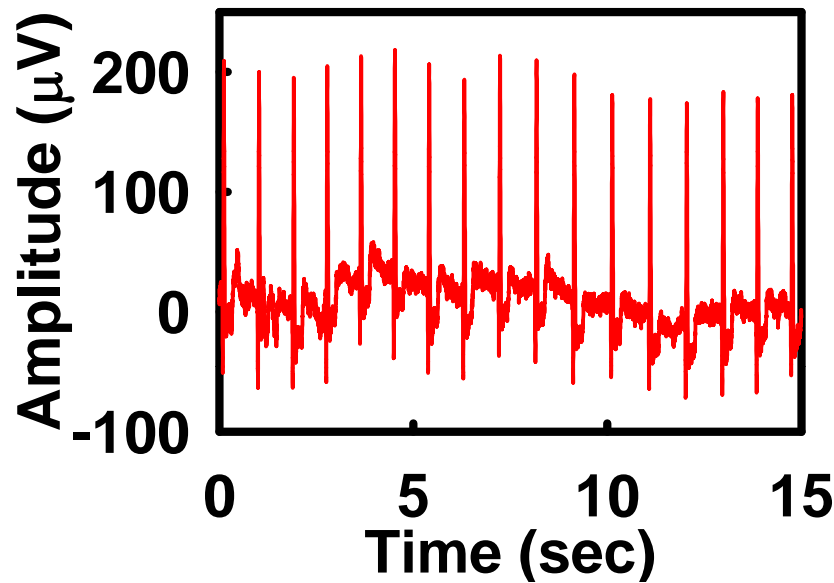
unpublished

'Epidermal' Electronic Systems – Ex. Devices

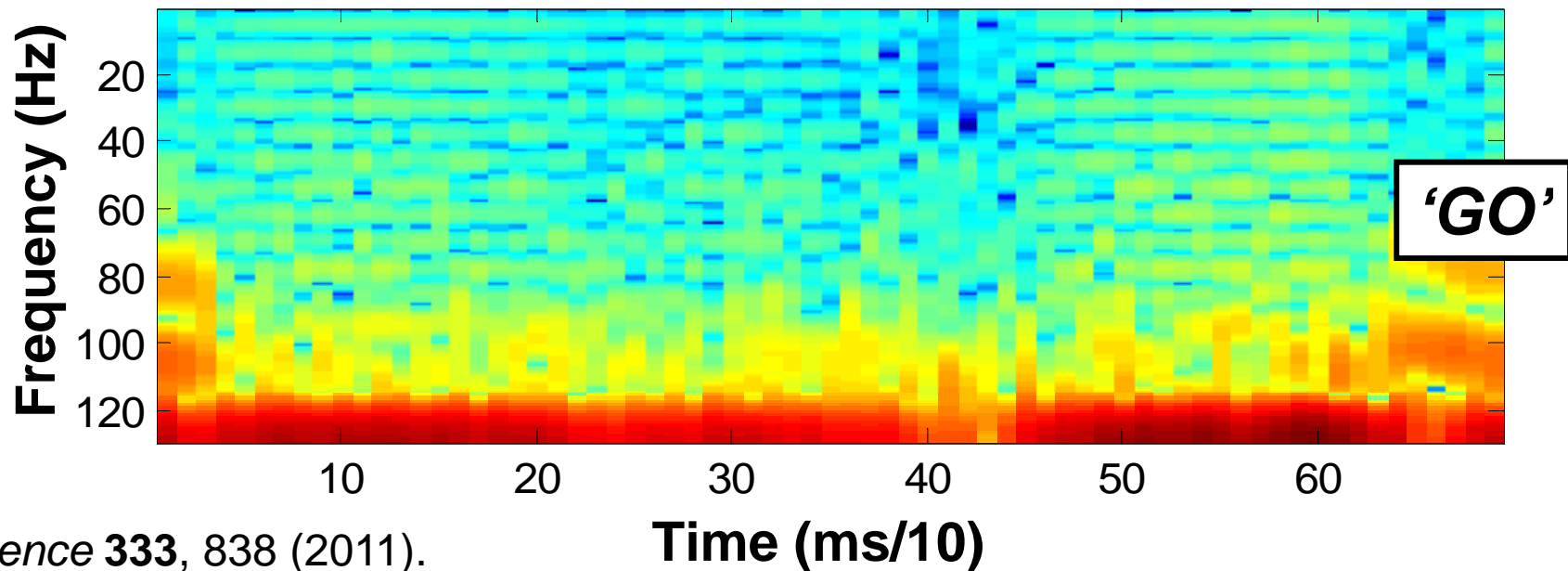
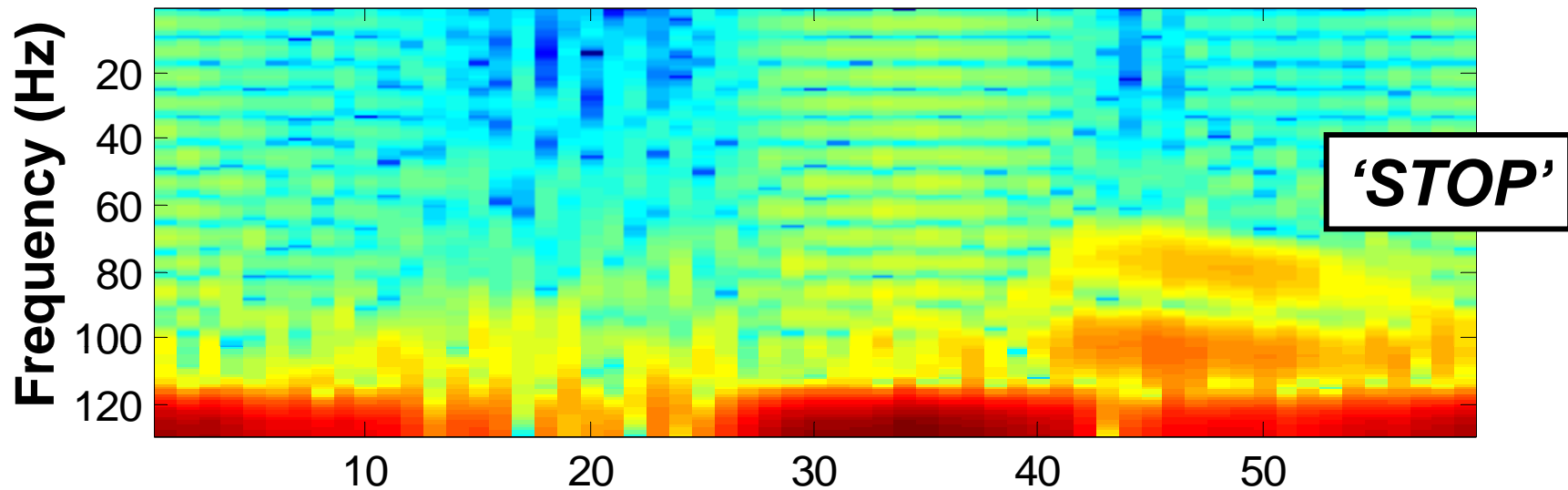


Science **333**, 838 (2011).

Measuring EKG, Forearm EMG via EES (w/ Coleman)



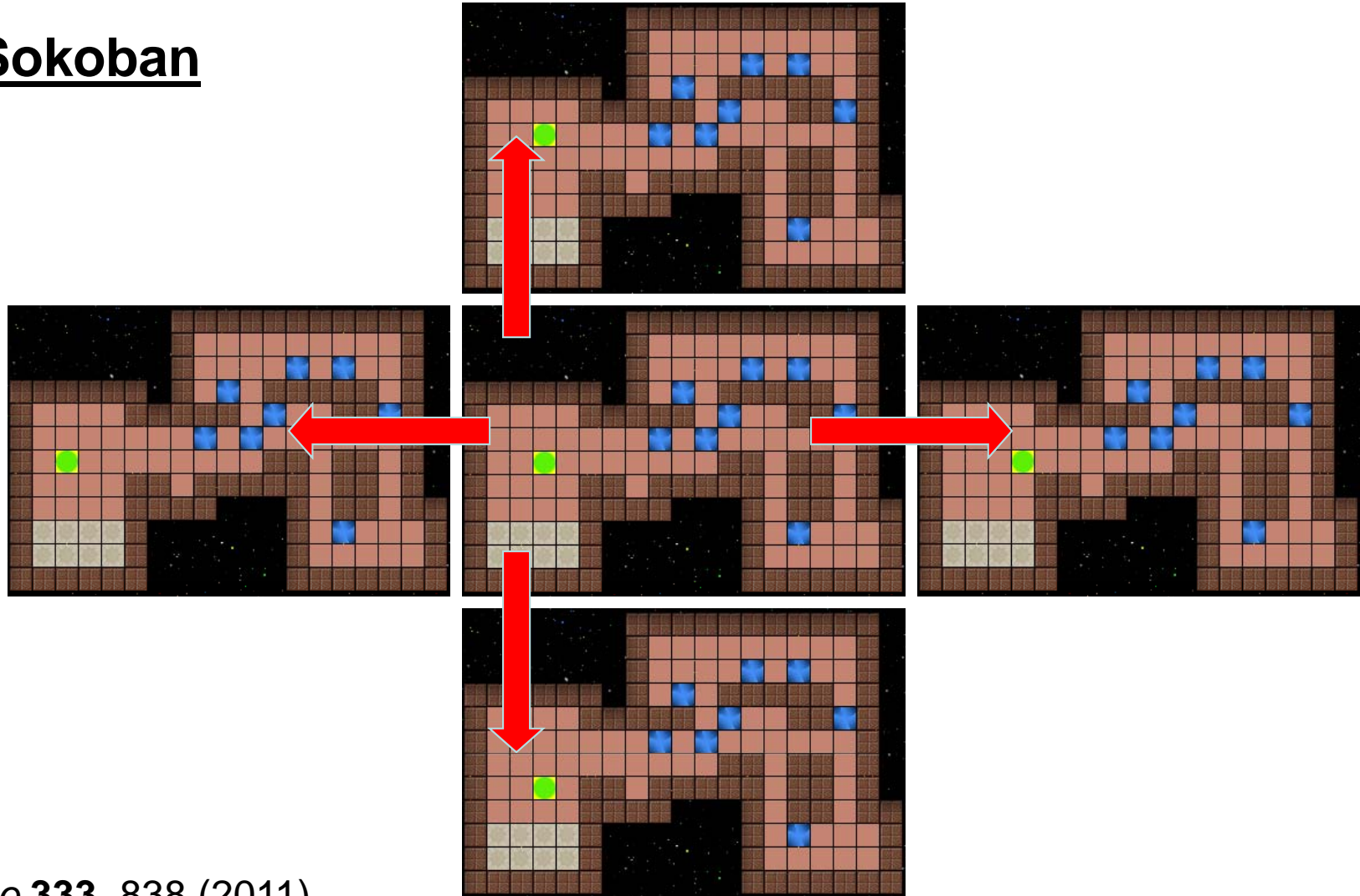
Measuring Speech via Neck EMG with EES (w/ Coleman)



Science **333**, 838 (2011).

Playing Video Games With An EES Controller (w/ Coleman)

Sokoban



Science **333**, 838 (2011).

Gestural Control of an RC Helicopter via Epidermal EMG



Senior Collaborators

Academic

Prof. Y. Huang (NU) – mechanics

Prof. P. Ferreira (UIUC) – manufact.

Prof. T. Coleman (UIUC) – EEG, interf.

Prof. D.-H. Kim (SNU) – mtl's, chem eng

Clinical

Dr. B. Litt (Penn) – neurology

Dr. D. Callans (Penn) – cardiology

Dr. M. Slepian (Sarver) – cardiology

Dr. J. McDonald (JHU) – rehabilitation

Dr. I. Efimov (Wash Univ) -- cardiology

